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(54) An apparatus for manufacturing a semiconductor material

(57) An apparatus for manufacturing a semiconductor material includes a load-lock chamber which can contain a cassette for holding at least one wafer for taking the wafer into or out of the apparatus, a process furnace for conducting a treatment to the wafer, and a transfer chamber for transferring the wafer between the load-lock chamber and the process furnace, wherein the apparatus further includes a pressure detector for detecting a pressure difference between in the process furnace and in the transfer chamber, and a gas flow controller for controlling a flow rate of a gas flow supplied to the transfer chamber in accordance with results of detection by the pressure detector.

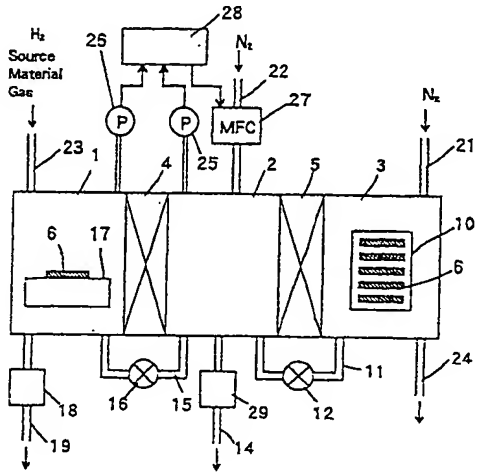

FIG. 1

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lock chamber 3 is substituted to nitrogen by vacuuming. After that, no pressure difference between the load-lock chamber 3 and the transfer chamber 2 are made by the bypass line 11 beforehand, and then the gate valve 5 of the load-lock chamber 3 is opened, and one of the wafers 6 is transferred to the transfer chamber 2 by the transfer instrument in the transfer chamber 2, and then the gate valve 5 is closed. Then, after the pressure difference between in the transfer chamber 2 and the process furnace 1 is made small by the bypass line 15 beforehand, and then the gate valve 4 is opened, and the wafer 6 is transferred to the process furnace 1. Then, the gate valve 4 is closed. After a predetermined process for the wafer 6 is conducted in the process furnace 1, the wafer 6 goes back to the load-lock chamber 3 from the process furnace 1 by returning the reverse pass with a similar sequence.

[0010] However, according to the conventional apparatus, there are problems described below. When the wafer 6 is transferred from the transfer chamber 2 to the process furnace 1, no pressure difference between in the process furnace 1 and in the transfer chamber 2 is made by opening the auto-valve 16 of the bypass line 15 before opening the gate valve 4, however, if the pressure difference is large, there generates a rapid gas flow in the bypass line 15 when the auto-valve 16 of the bypass line 15 opens due to the large pressure difference.

[0011] The rapid gas flow flows into the process furnace 1 if the pressure in the transfer chamber 2 is higher than that in the process furnace 1, and flows into the transfer chamber 2 if the pressure in the process furnace 1 is higher. Consequently, particles existing in the process furnace 1 or in the transfer chamber 2 are blown up thereby. The gate valve 4 is opened few seconds after the auto-valve 16 is opened, however, the blowing up of the particles continues for dozens of seconds, consequently there may occur contamination of the wafer 6 by the particles. The wafer 6 may be contaminated by the particles of about 80 particles/wafer if the pressure difference between in the process furnace 1 and in the transfer chamber 2 is 7 torr or more, for example.

[0012] Further, in the process furnace 1, the gas flow from the bypass line 15 does not flow directly forward the front surface side of the wafer 6 since the end of the bypass line 15 is provided below the back side of a susceptor 17 in the process furnace 1, however, the gas flow may reach to the front surface side of the wafer 6 from the back side surface of the susceptor 17 if the gas flow is rapid, and the gas flow may blow up polysilicon deposited on the front surface side of the wafer 6 as particles.

[0013] Further, a pipe of the bypass line 15 is relatively narrow, and it takes some time to make the pressures in the chamber or the furnace same, even if the auto-valve 16 of the bypass line 15 is opened, therefore the pressures in the chamber and the furnace do not become the same before the gate valve 4 is opened, if the pressures are widely different between in the process furnace 1 and the transfer chamber 2. Consequently, there may generate a rapid gas flow which flows through the gate valve 4 just when it is opened, and it may cause blowing up of particles.

[0014] The pressure difference between in the process furnace 1 and the transfer chamber 2 is caused by mainly following 2 reasons.

[0015] The first reason is an existence of the pressure difference between in the exhaustion pipes 19 and 14 respectively provided to the process furnace 1 and the transfer chamber 2. The exhaustion pipe 14 provided to the transfer chamber 2 is open directly to the air through the butterfly valve 13. On the other hand, the exhaustion pipe 19 provided to the process furnace 1 is open to the air through the gas scrubber 18. Therefore, the pressure in the exhaustion pipe 19 of the process furnace 1 is generally lower than that in the exhaustion pipe 13 of the transfer chamber 2 by 7 torr or more.

[0016] The second reason is a choking of the exhaustion pipe 19 provided to the process furnace 1. Products generated by a reaction between the non reacted source gas and the other gases are deposited in the exhaustion pipe 19, whcih may choke the pipe. Consequently, the pressure in the process furnace 1 connected with the exhaustion pipe 19 gradually increases, and finally becomes higher than the pressure in the transfer chamber 2 connected with the exhaustion pipe 14 by 2 torr or more.

[0017] Thus, contamination of the wafer 6 occurs due to the blowing up of particles when the pressure difference between in the process furnace 1 and the transfer chamber 2 becomes large. Further, if the pressure in the process furnace 1 is higher than that in the transfer chamber 2, the etching gas or residual source gas in the process furnace 1 flows into the transfer chamber 2. Such corrosive gases may corrode the transfer instrument in the transfer chamber 2.

Brief Summary of the Invention

[0018] The object of the present invention is to provide an apparatus for manufacturing a semiconductor material wherein particles attachment to a semiconductor substrate during transferring and defects in devices are avoided by reducing the pressure difference between in the process furnace and the transfer chamber.

[0019] The present invention provides an apparatus for manufacturing a semiconductor material which includes a load-lock chamber which can contain a cassette for holding at least one semiconductor substrate for taking the semiconductor substrate into or out of the apparatus, a process furnace for conducting a treatment to the semiconductor substrate, and a transfer chamber connected to the load-lock chamber and the process furnace intervened by a gate valve for each for transferring the semiconductor substrate between the load-lock chamber and the process furnace,

the load-lock chamber 3 is opened and the cassette 10 is taken into or out of the load-lock chamber 3. In order to purge the air penetrated into the load-lock chamber 3 while opening the door, a pressure of the load-lock chamber 3 is reduced by a vacuum pump which is not shown in Fig. 1 through the exhaustion pipe 24 for 10 minutes to 10 torr. After enough vacuum reduction of the air from the load-lock chamber 3, the vacuum pump is stopped and the pressure in the load-lock chamber 3 is restored to be at the atmospheric pressure by introducing nitrogen. When the pressure in the load-lock chamber 3 is restored to be at the atmospheric pressure, the auto-valve 12 of the bypass line 11 is opened and the usual state is restored.

[0030] Respecting operation between the transfer chamber 2 and the process furnace 1, when the wafer 6 is transferred from the transfer chamber 2 to the process furnace 1, the auto-valve 16 of the bypass line 15 is opened five seconds before the gate valve 4 is opened and is closed at the same time as the gate valve 4 is closed. The reason why the autovalve 16 of the bypass line 15 is opened five seconds before the gate valve 4 is opened is to make the pressures in the transfer chamber 2 and in the process furnace 1 be the same before the gate valve 4 is opened, as described before.

[0031] In this apparatus, it makes possible to control the pressure in the transfer chamber 2 for a flow rate of nitrogen supplied through the MFC 27 by installing the throttle 29 to the exhaust ion pipe 14 of the transfer chamber 2. In more specific, the flow rate of nitrogen supplied through the MFC 27 is kept at typically 15 liters /min. by adjusting an opening level of the throttle 29 of the exhaustion pipe 14.

[0032] Further, the pressure in the process furnace 1 is always monitored by the controller 28 through the manometer 26, and a difference of the pressure in the transfer chamber 2 and in the process furnace 1 is kept at a predetermined value or less by controlling the flow rate of nitrogen automatically. In more specific, the pressures P25 and P26 in the transfer chamber 2 and the process furnace 1 are measured respectively, and the pressure difference (P25-P26) is calculated. Then, a difference of the measured pressure difference to a target pressure difference, determined so that the pressure in the transfer chamber 2 is higher (for example, P25-P26 = 2 torr), is adjusted by controlling the nitrogen gas flow rate from the MFC 27.

[0033] Thus, according to the invention, an apparatus for manufacturing a semiconductor material is provided wherein it is possible to reduce particles attached to the wafer while transferring and to restrict generation of defects in the products.

Examples

[0034] In the apparatus shown in Fig. 1, it is measured a relation between the pressure difference (P25-P26) in the transfer chamber 2 and in the process furnace 1 before the auto-valve 16 and the gate valve 4 are opened and number of particles attached to the wafer 6.

[0035] The wafer 6 of which number of particles attached to is already measured is transferred from load-lock chamber 3 to the process furnace 1 through the transfer chamber 2, and the wafer 6 is returned to the load-lock chamber 3 from the process furnace 1 without conducting any treatment. In the above sequence, the pressure in the process furnace 1 is set at 760 torr, the process furnace 1 is heated to 700°C in the atmosphere of hydrogen. Number of particles attached to the wafer 6 which has been returned to the load-lock chamber 3 is measured for various conditions of the pressure in the transfer chamber 2. The pressure condition in the transfer chamber 2 is changed by changing a flow rate of nitrogen supplied from the MFC 27. Then, number of increased particles of 1. 6 nm or more compared with the initial number is counted. Fig. 3 shows a relation between: the pressure difference (P25-P26) (torr) between in the process furnace 1 and in the transfer chamber 2 which is represented by the relative pressure of the transfer chamber 2 to the process furnace 1; and number of the increased particles. According to the results of the measurements, the particle number is extremely increased compared with the initial number if the the pressure in the transfer chamber 2 is higher by 6 torr than that in the process furnace 1. On the other hand, increase of particles attached to the wafer 6 during the sequence is almost suppressed if the relative pressure of the transfer chamber 2 to the process furnace 1 is kept within -2 to 6 torr.

Claims

1. An apparatus for manufacturing a semiconductor material which comprises a load-lock chamber containing a cassette for holding at least one semiconductor substrate for taking the semiconductor substrate into or out of the apparatus, a process furnace for conducting a treatment to the semiconductor substrate, and a transfer chamber connected to the load-lock chamber and the process furnace intervened by a gate valve for each for transferring the semiconductor substrate between the load-lock chamber and the process furnace:
wherein further comprising a pressure detector for detecting a pressure difference between in the process furnace and in the transfer chamber, and a gas flow controller for controlling a flow rate of a gas flow supplied to the transfer chamber in accordance with results of detection by the pressure detector.

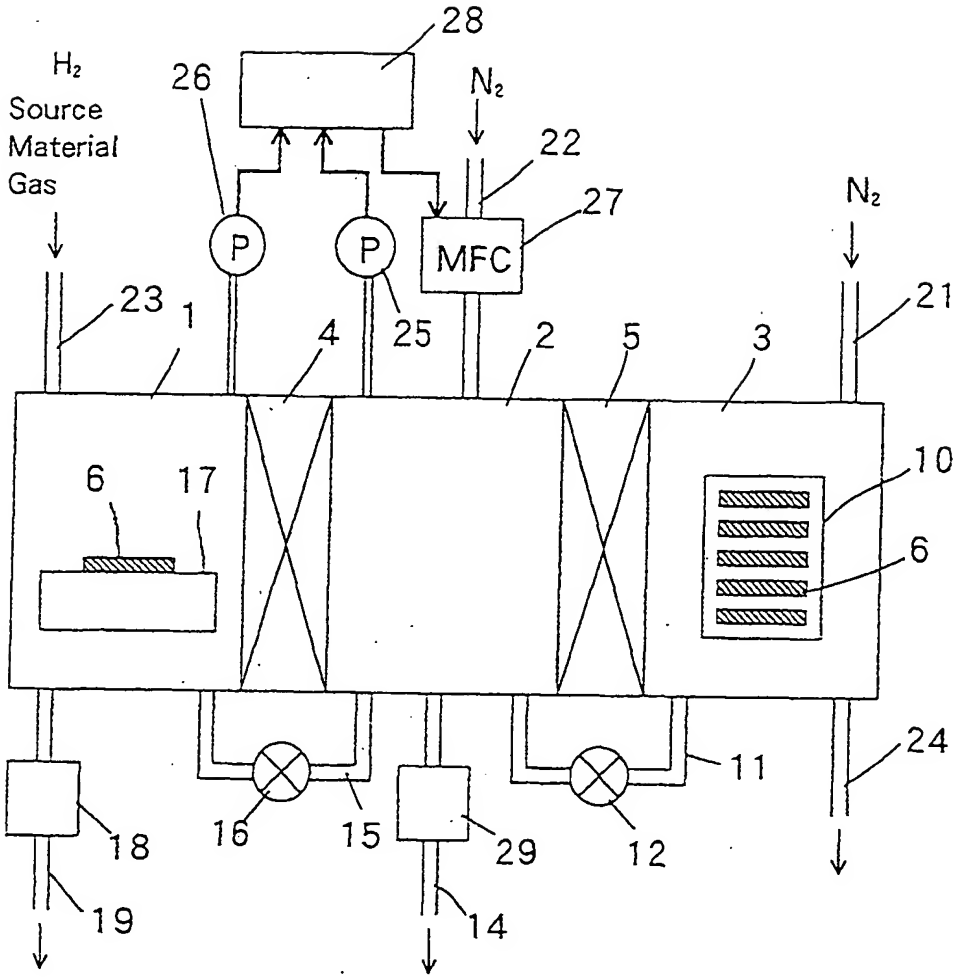
H2
Source
Material
Gas
26
28
N2
22
27
MFC
P
P
25
N2
21
23
1
4
2
5
3
6
17
10
6
11
24
18
16
15
29
12
19
14

FIG. 1